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Beta Carotene Content of Commonly Consumed Foods and Soups in Nigeria

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Abstract: Deficiency of vitamin A in the diets represents one of the key challenges affecting the developing world. However, beta-carotene is the most available/important source of pro-vitamin A in the diets of most people living in developing countries. It reportedly provides about 66% of vitamin A in their diets. In West Africa, much carotenoid is obtained from red palm oil, which is widely used in cooking. However, it has been reported that these available sources of pro-vitamin A are very often neglected by children and pregnant women who are more vulnerable or at risk of vitamin A deficiency. Also amount of dietary intakes of beta-carotene of Nigerians is not known. This study therefore aimed at determining the beta-carotene contents of some selected commonly consumed foods and soups in Nigeria. These foods and the soups were selected to reflect consumption across the three agro-ecological zones in Nigeria. Food samples were purchased from food vendors and were also obtained from people from these zones. The extraction of beta carotene in the matrices of the food samples was done using a modified method; while the determination of the beta carotene contents of the extracts was done using the ultra violet visible spectrophotometer. The beta carotene contents of the foods varied in each food group and the values obtained were similar to the values previously reported in the literature. Soups and stews had the highest concentrations of beta carotene. Also foods such as “moinmoin”, “akara”, bean porridge and yam pottage prepared with red palm oil had moderate amounts of beta carotene. Foods prepared from yellow maize such as “ogi”/pap and “eko”/“agidi” had lower values. Generally, the beta carotene content of foods analyzed ranged from 6 µg/100 g in Fufu to 13,279 µg/100 g in ‘edikang ikong’ soup. The beta carotene content of a considerable number of foods and soups commonly consumed in Nigeria is hereby provided. This result therefore adds to the ‘food composition data’ available for Nigeria. Food consumption studies and dietary management will benefit from these analyses. Since dietary improvement and diversification has been recognized as the long term solution to controlling VAD, soups containing enough green leafy vegetables such as “edikang ikong”, “efo riro”, palm oil stew and foods prepared with red palm oil, which are rich sources of provitamin A should be consumed in increased amounts to address vitamin A deficiency.

Key words: Beta carotene, vitamin A deficiency, staple foods, soups

INTRODUCTION

Beta carotene is the most available and therefore important source of provitamin A in the diet of most people living in developing countries, providing about 66% of vitamin A in their diets. The carotenoids (e.g. beta-carotene and lycopene) are micronutrient antioxidants that have integral role in regulating vital metabolic reactions in the body (Abiaka *et al*., 2002). Nowadays, the major interest in carotenoids which are found in plants is not only due to their provitamin A activity but also their antioxidant action of scavenging oxygen radicals and reducing oxidative stress in the organism (Rao and Honglei, 2002). Epidemiological evidence also suggests that carotenoids-rich foods protect against some chronic diseases; including certain type of cancer, cardiovascular disease and age-related macular degeneration (National Research Council, 1982). In West Africa much carotene is obtained from red palm oil, which is widely used in cooking (Latham, 1997).

However, it has been reported that the available plant sources of provitamin A are very often not eaten by children and pregnant women who are vulnerable groups at risk of vitamin A deficiency (WHO, 1976). Thus, it is common to find destruction of eyes by xerophthalmia due to Vitamin A Deficiency (VAD) in environments where carotene-rich green leaves are abundant. The prevalence of VAD in Nigeria was given as 28.1% for preschool children and 4.7% for mothers (UN/SCN, 2004). Maziya-Dixon *et al*. (2006) similarly reported 29.5% prevalence of VAD in children less than five years of age in Nigeria, the proportion of which was highest in the northwest dry savannah agro-ecological zone of Nigeria. It has been suggested that the high prevalence of VAD in Nigerian communities was due to low dietary intake of vitamin A, dominant dietary staple being cassava and other carbohydrate-dense foods that are virtually devoid of vitamin A and carotenoids (Tee, 1995). VAD has also been described as essentially a consequence of poor socio-economic environment (Oomen, 1976).

Since dietary diversification has been recognized as the long term solution to VAD for supporting VAD prevention and control programmes emphasized by the International Vitamin A Consultative Group (IVACG), it would therefore be necessary to identify and determine the beta carotene content of commonly consumed foods and soups in Nigeria. However, there is little published information on the carotenoid composition of foods that constitute the bulk of the diets in Nigeria and such information is important for evaluation of diets, establishment of locally relevant dietary guidelines and future nutritional research on the relationship between diet, health and disease.
This study was therefore aimed at providing current data on the beta carotene content of commonly consumed foods and soups in Nigeria.

MATERIALS AND METHODS

Sample selection: Staple foods and soups commonly consumed in the three agro-ecological zones in Nigeria, namely the dry savannah, moist savannah and the humid forest, including their cafeteria recipes (HETAN, 1993) were identified by literature review. Samples of the identified foods and soups in the dry savannah were obtained from food vendors in *Sabo* area of Ibadan, where the people from that region reside, while samples of the identified foods and soups from the moist savannah and the humid forest were purchased from food vendors in *Agbowo*, *Bodija* and Total garden areas of Ibadan. Samples of each food item were collected from more than two sources in order to get a representative sample of the foods.

Preparation of samples for laboratory analysis: The food samples were prepared in the laboratory by homogenising large samples and subsequently reducing them in sizes and amount for the laboratory analyses. Each wet food sample was weighed and a portion was taken out to determine the moisture content of the food. The remaining portion was then placed in hot air oven to reduce the moisture content of the food sample and prevent spoilage. Each well dried food sample was then grinded to a fine smooth-texture sample with the aid of mortal and pestle in order to increase the surface area of the food sample for the subsequent analysis. The food samples were then kept in moisture free container and labeled.

Beta carotene extraction, saponification and partitioning: Extraction of beta carotene was done in order to release and isolate the beta carotene from the food matrix using a modified method that was claimed to have a better extraction efficiency (Howe and Sherry, 2006). Weighing 0.6 g of each sample in duplicates into clean already labeled 25 mls centrifuge tubes and adding 6 ml of ethanolic Butylated Hydroxyl Toluene (BHT) to each test tube containing each food sample, after which they were vortexed for 20 seconds to ensure proper mixing and then placed in an 85°C water bath for five minutes. Then, 0.5 ml of 80% Potassium Hydroxide (KOH) was added to the heated ethanol-food sample mixtures, to saponify the potentially interfering oils (Nollet, 1992). Samples were then mixed by vortex and returned to the 85°C water bath for 10 min with an additional mixing at 5 min. Samples were immediately placed in ice and 3 ml cold deionized water was added to each tube. Hexane (3 mls) was then added to the cooled samples to extract the carotenoids using centrifugation to separate the layers. Another 3 mls hexane was added twice into the remaining aqueous layer and a simultaneous centrifugation to separate the layers. The upper separated organic layer containing the extracted carotenoids was carefully removed into a clean already labeled test tube and the lower layer was discarded. The carotenoid extract of each food was then made up to 10 mls to have equal volume of extract. An ultra violet visible spectrophotometer was used for quantification of the total carotenoid extract.

Spectrophotometric analysis: A JEN WAY 6305 UV/Visible Spectrophotometer with a wavelength set at 450 nm was used for the analyses. The spectrophotometer was calibrated and zeroed with hexane blank. The cuvette was properly cleaned and rinsed with the next sample after each sample.

Preparation of the standard solution and the standard curve for beta carotene: Different concentrations of the standard solution were prepared using a 95% UV Beta carotene type 1 (10 G) produced by Sigma Chemicals. A beta carotene standard (0.01 g) was dissolved in 10 mls hexane and volume was made up to 100 ml with hexane; thus becoming the stock solution of 100 µg/ml. A working solution/working standard of 20 µg/ml was therefore prepared from the 100 ml stock solution. From the 20 µg/ml stock solution, varying concentrations of 1, 2, 3, 4, 5, 6 and 7 µg/ml standard solutions were prepared. The absorbance (A) of each concentration was measured using the uv-visible Spectrophotometer at 450 nm wavelength. A standard curve of absorbance against concentration was then plotted.
The carotenoid concentration of the food extracts was determined by absorbance of each sample as read on the spectrophotometer at 450 nm and read off on the standard curve.

Quality assurance: A Standard Reference Material (SRM 2385) which consists of slurred spinach intended primarily for use in validating laboratory analysis methods for carotenoids, proximate and other analysis was used for the purpose of quality assurance. The

Table 1: Commonly consumed foods and soup/stews in Nigeria

Food group		
Roots and Tubers	***Cassava and its products**	****Yam and its products**
	Eba/Garri, Fufu, Cassava flour (Lafun)	Boiled yam, Yam flour (Amala), Pounded yam, Yam pottage
Cereals and Grains	**+Maize and its products**	**++Rice and its products**
	Ogi/Pap, Eko/Agidi, Tuwo Masara.	White rice, Jollof rice, Fried rice, Tuwo Shinkafa.
Legumes	**#Beans and its products**	
	Moinmoin, Akara, Bean porridge, Boiled beans	
Soups	**Draw soups**	**Vegetable soups**
	Kuka, Kubewa,[1] Okro, [2]Ewedu, Ogbonno.	[3]Efo riro, Egusi and Efo, Edikang-ikong, Oha
Stew	**Palm oil stew and vegetable oil stew**	

**manihot utilissima, **dioscorea ssp., +zea mays, ++oryza sativa, #vigna unguiculata, [1]hibiscus esculenta, [2]olitorus cocchorus, [3]amaranthus ssp*

certified concentration values of carotenoids in SRM 2385 provided by the National Institute of Standards and Technology (NIST) and other collaborating laboratories are given as values between 19.2±2.9 (Willie and John, 2003). The values obtained from this study using the Kurilich and Juvic method gave a mean carotenoid value of 20.415.

This value demonstrated the accuracy, reproducibility and validity of the method used in this analysis for beta carotene.

Statistical analysis: Minimal statistical analyses were performed using SPSS 13.0 for Window Software (SPSS, Chicago, IL, USA). The beta carotene, the proximate and some micronutrient content values of the commonly consumed foods and soups were summarized with means and standard deviations.

RESULTS

The moisture and the beta carotene contents of some selected commonly consumed foods and soups (and stew) in Nigeria are summarized with mean ± standard deviation in Tables 2-5. Generally, the beta carotene contents of foods analysed ranged from 6.00 µg±0.71/100 g in Fufu to 13,279.00±1.06 µg/100 g in *edikang ikong* soup.

As shown in Table 2, the beta carotene of foods prepared from roots and tubers was highest in yam pottage (607±1.00 µg/100 g) and lowest in fufu (6.00±0.71 µg/100 g). Among the cereal/grain foods in Table 3, fried rice (379 ±1.00 µg/100 g) had the highest concentration of beta carotene, closely followed by jollof rice (192.00±1.00 µg/100g) and yellow *eko/agidi* (180.00±1.00 µg/100 g). The least concentration was found in *tuwo masara* (47.00±0.33 µg/100 g) followed by white *Ogi*/pap (68.00±0.14 µg/100 g) and white rice (68.0±0.33 µg/100 g). The beta carotene in the selected legume foods in Table 4 was highest in *moinmoin* (8000.50±0.28 µg/100 g) but lowest in cooked/boiled beans (126.00±0.83 µg/100 g).

The selected soups and stews generally had higher concentration of beta carotene than the foods. The concentration of beta carotene among the soups ranged from as low as 1369.00±1.02 µg/100 g in *kubewa* soup

Table 2: Beta carotene contents *Root/Tubers and Products

Foods	Moisture (%)	β-carotene (µg) Mean±SD
Eba/garri (white)	76.05±0.90	93.00±0.95
Eba/garri (yellow)	71.33±0.93	321.00±0.57
Fufu	73.55±0.87	6.00±0.71
Cassava flour (Lafun)	73.51±0.59	155.00±0.42
Boiled yam	76.61±0.02	22.00±0.00
Yam flour (Amala)	78.31±0.19	39.00±0.00
Pounded yam	73.73±0.74	97.00±0.64
Yam pottage	73.73±0.74	607.00±1.00

*per 100 g food sample

Table 3: Beta carotene contents *Cereals/Grains and Products

Cereals/Grains	Moisture (%)	β-carotene (µg) Mean±SD
Ogi/Pap (yellow)	9.75±0.25	221.00±0.85
Ogi/Pap (white)	92.39±0.40	68.00±0.14
Eko/Agidi (yellow)	87.82±0.22	180.00±0.13
Eko/Agidi (white)	88.57±0.16	97.00±0.92
Tuwo Masara	81.87±1.21	47.00±0.33
White rice	66.75±0.35	68.00±0.33
Jollof rice	62.91±0.29	192.00±1.00
Fried rice	60.05±0.08	379.00±0.01
Tuwo Shinkafa	82.05±0.64	122.00±0.92

*100 g food sample

to as high as 13279.00±1.06 µg/100 g in *edikang ikong* soup (Table 5). Also, between the two stews analysed the palm oil stew (7872.00±1.00 µg/100 g) apparently had higher concentration of beta carotene than the stew produced with other vegetable oil (6539.00±0.98 µg/100 g).

DISCUSSION

The significance of food and nutrient composition data cannot be over emphasized in the dietary treatment of disease or in any quantitative study of human nutrition; the earlier food composition studies were carried out to determine the chemical nature of the principles in foods that affect human health. Food composition data are used primarily for the assessment and the planning of human energy and nutrient intakes (Greenfield and Southgate, 2003). However, there are few food composition tables available for use in developing countries and all of these contain gaps in terms of foods and several nutrients. Besides, these tables contain

Table 4: Beta carotene content of *Cowpeas /Beans and Products

Legumes	Moisture (%)	β-carotene (μg) Mean±SD
Moinmoin (Red Palm oil)	76.86±0.62	8000.50±0.28
Moinmoin (*Veg. oil)	73.87±0.94	387.00±1.13
Akara (Red Palm oil)	46.68±0.71	3395.00±0.78
Akara (Veg. oil)	53.45±0.76	263.00±1.12
Beans porridge	62.74±0.73	4257.00±0.98
Boiled beans	58.19±1.03	126.00±0.83

*100 g food sample

Table 5: Beta carotene content of *Soups and Stew

Soups	Moisture (%)	β-carotene (μg) Mean±SD
Kuka	95.52±0.59	1676.00±1.09
Kubewa	95.51±0.29	1369.00±1.02
Okro	92.15±0.35	2786.00±0.33
Ewedu	88.17±0.74	8378.00±0.14
Ogbonno	74.42±0.17	13134.00±0.31
Efo riro	74.76±0.14	12976.00±0.00
Egusi and Efo	58.02±0.11	13047.00±0.78
Edikang ikong	71.62±0.18	13279.00±1.06
Oha	76.11±0.01	10299.00±1.07
Stew		
Palm oil stew	79.36±0.19	7872.00±1.00
Vegetable stew	84.17±0.35	6539.00±0.98

*100 g soup/stew sample

data that are not recent and have information mostly on raw foods. Food composition data on cooked foods in these regions are scarce and the available compilation on Nigerian foods by Oguntona and Akinyele (1995) contains data on only few dishes. Although some authors have reported values on the proximate and certain micronutrients such as iron, zinc, copper (Ene-Obong and Madukwe, 2001) including an antinutrient, phytates for dishes such as Edikan ikong soup, Jollof rice, Ogbonna soup, bean pudding (moinmoin), melon seed and vegetable soup (egusi and efo) and yam pottage (Onabanjo and Oguntona, 2003), there is still a dearth of information on the beta carotene contents of most common dishes served traditionally at home. So, this study has been able to determine the beta carotene contents of some foods and soups commonly consumed across the three agro-ecological zones in Nigeria.

It has been an established fact that carotenoids exist in Nigerian diets, but we were not sure of the amount present, more so, reports on the carotenoid content of cooked foods in Nigeria are scarce. The diets of population groups in the tropical world rarely contains large amounts of milk, eggs or liver, which are the rich sources of preformed vitamin A; therefore, there is a great deal of dependence on carotenoids, particularly from leafy vegetables, as source of vitamin A (Tee, 1995).

The higher level of beta carotene contents observed in some foods such as *moinmoin* (red palm oil), *akara* (red palm oil), bean porridge and some soups such as *edikang ikong*, *ogbonno, egusi and efo, efo riro,* could invariably be attributed to the presence of palm oil, one of the richest sources of carotenoids, in those foods and soups. The high beta content found in *edikang ikong* soup could further be attributed to the mixture of at least two vegetables namely waterleaf and "*ugwu*" besides the contribution of red palm oil to the beta carotene level. Also, some appreciable amounts of beta carotene observed in some cereal foods such as *ogi*/pap (yellow) and *eko/agidi* (yellow) could be attributed to the inherent carotenoid content of the yellow maize used, unlike the lower concentration observed in the those made from white maize. The paucity of previous work on beta carotene contents of commonly consumed foods in Nigeria precludes comparison of the results.

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